7. FLIGHT PROGRAM MANAGEMENT AND ASSESSMENT

7.1 OVERVIEW

Flight programs for the Space Science Enterprise (SSE) are initially developed as candidates for funding from multiple advanced concepts for science mission investigations that have a common purpose. Selected concepts are then packaged into candidate programs as budget augmentation units, and submitted to the Space Science Enterprise Associate Administrator (SSE AA) for potential funding as part of an upcoming President's budget. If successful, the programs then enter a Formulation Phase after the Formulation Authorization Document for the Program is written and signed. Formulation of the first project in the program begins after the goals and commitments for the program have been established. Program/Project management follows the approach defined in NPD 7120.4 and NPG 7120.5. Projects are defined in a Formulation Phase and pass through an Approval gate into Implementation.

The Office of Space Science (OSS) has defined Formulation for a project to consist of two parts, Phases A & B, while Implementation consists of Phases C, D and E. The fourth 7120 component, the Evaluation subprocess, provides for independent assessments by teams external to the project. The relationship of the NPG process to the traditional phased program/project approach was fully described in Subsection 2.2.4 and in Figure 2.2-3. Flight program management process flow is illustrated in Figure 7.1-1.

The SSE AA delegates flight program authority and responsibility to members of the NASA Headquarters OSS organization, or specifically, Science Directors or Division Directors depending on whether the program is science theme specific, cross-theme, or technology-based in nature. The Directors rely upon the Program Executive (PE) to carry out the flight program responsibilities allocated to the Enterprise Associate
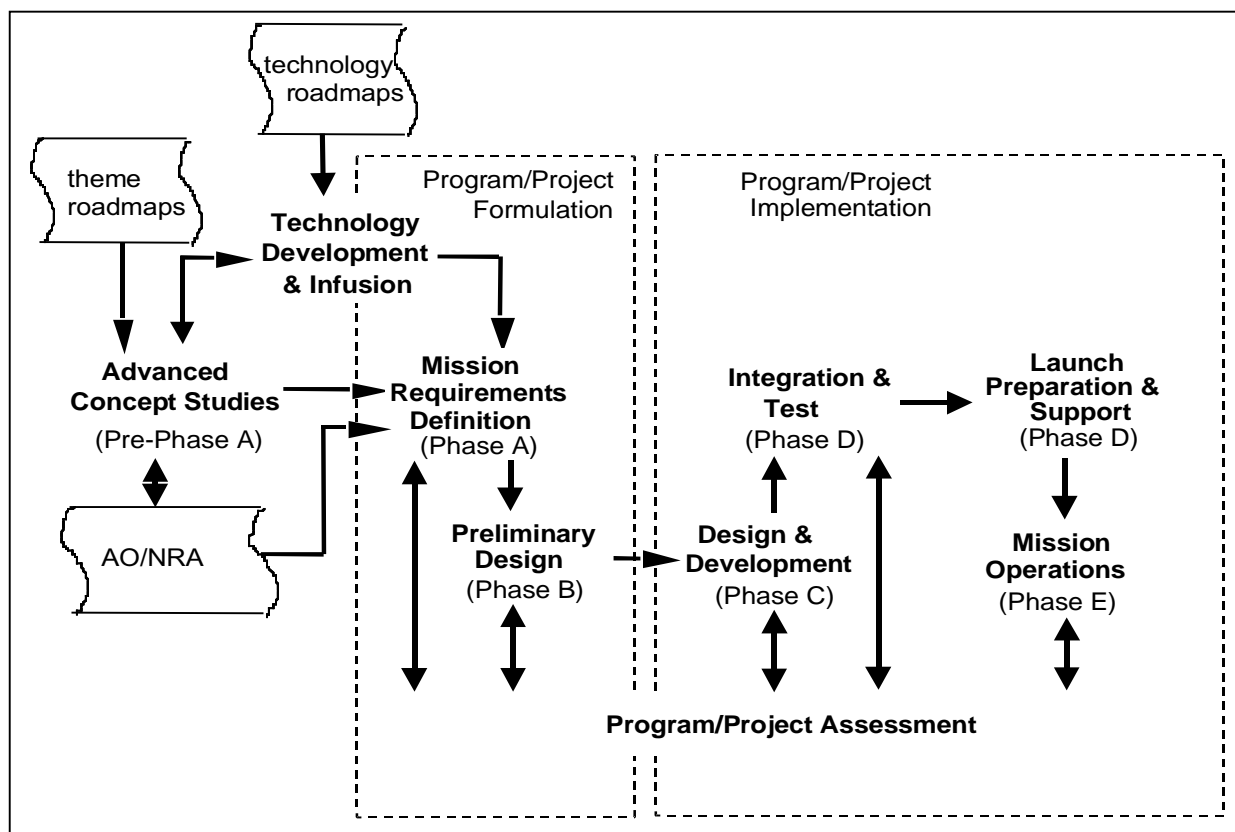

Figure 7.1-1 Space Science Flight Program Management Process Flow

Administrator (EAA) in the "7120"documents, including program and project formulation, implementation oversight, and performance assessment. Much of the Program Executive's work is associated with providing policy guidance to NASA Centers, generating top-level requirements, managing agreements (interagency, inter-Center, and international), and evaluating program and project performance against requirements. The Program Executives' responsibilities are performed under the oversight of the Deputy AA (DAA) for Space Science.

All programs and projects are required to have clearly defined objectives, to be consistent with the NASA and Space Science Enterprise Strategic Plans, and to have a comprehensive definition of cost, schedule, and technical commitments. These commitments, and the associated agreements and acquisition strategy, are controlled throughout the project lifecycle, from Formulation through Implementation. They are the principal focus of the Evaluation subprocess, and are documented in a Program Commitment Agreement and a Program Plan.

SSE activities occurring prior to the Formulation subprocess are discussed in Subsection 7.2, and those during each subprocess are described in Subsections 7.3 through 7.6. The respective roles of the key program management positions are discussed in Subsection 7.7, particularly those of the Program Executive, the Program Scientist, and the Program Manager. The latter is a role delegated to a NASA Center, involving day-to-day oversight and management of the implementation of the program and the projects within the program. Finally, the Section ends with discussions of the tailoring of requirements and of financial control.

7.2 PRE-FORMULATION (PRE-PHASE A)

NPG 7120.5 specifies that the Formulation process for a new program begins at the approval of a Formulation Authorization Document (FAD). However, the Program Executive's responsibility in developing the content of a candidate program begins well before a program obtains an approved FAD. For SSE programs, this occurs during a period known as Pre-Formulation, or Pre-Phase A.

The PE's role in Program Pre-Formulation is to support the introduction of future programs and associated technology requirements into the SSE roadmap and budget. This is achieved by supporting the Science Directors, scientists and technologists in the development of revised science roadmaps, which are discussed specifically in Subsection 7.2.3. The PE is responsible for coordinating with the theme technologists to ensure that the technology requirements associated with the revised science roadmaps are incorporated into the revised SSE technology roadmap. The PE also supports the science themes in the grouping and advocacy of sets of mission concepts into new budget initiatives, which, if successful, transition into new programs. This is often facilitated by science workshops held to refine requirements and obtain science community advocacy.

For Project Pre-Formulation, the Program Executive supports Advanced Concept Studies (Subsection 7.2.1) and promotes the maturation of advanced concepts into pre-concepts (Subsection 7.2.2) using Science and Technology Definition Teams. The PE is also responsible for the identification, oversight, and advocacy of mission-specific technology development necessary to support the advanced concepts selected for inclusion into the science roadmap.

7.2.1 Advanced Concepts

Advanced concepts for future science investigations are derived from three distinct sources:

- Independently-funded publications in peer reviewed journals and presentations at science conferences;
- NASA-funded Research Announcements for new mission concepts; and
- Management direction to a NASA Center.

Several advanced mission concepts to support gathering and analysis of science data (i.e., investigation) may be developed independently for a narrow area of space science.

If the advanced concept studies are funded outside of SSE funding authority, no Program Executive action is required, other than to remain cognizant of study results for synergy or to avoid duplication. If the SSE or theme issues an NRA for new mission concepts, the PE works with the Science Director to issue the NRA and serves as the Contracting Officer's Technical Representative

(COTR) for the resultant grants. The Science Director and theme's Program Scientists in OSS select the winning proposals. The PE interacts with the Headquarters grants office to implement and extend the grants, and distributes the final reports to the theme Program Scientists and Science Director.

If the SSE AA or the NASA Administrator directs that a Center should develop an advanced concept, the PE prepares a letter of direction and a task statement, and facilitates the funding of the task using funds indicated by the SSE AA or Science Director. This letter is signed by the SSE AA, or a Science Director in OSS.

The science community melds various advanced concepts, focused on a narrow area of science investigation, into a consensus concept during workshops supporting the development of a science roadmap (refer to Subsection 7.2.3) for the theme. The science community may or may not accept the consensus concept for inclusion into the roadmap.

7.2.2 Pre-Concept Definition

If the consensus concept is accepted as a new mission in the science roadmap, the Science Director for the theme appoints the science participants for Science and Technology Definition Teams (STDT) to mature the concept from an advanced concept into a pre-concept. The Program Executive, and the Centers involved in theme activity, support the STDT's with spacecraft concept studies, costing, engineering analysis, and technology support. The STDT product, a report, is coordinated with the science community using the science advisory bodies, and contains the following information as a minimum:

- Science objectives;
- Operations concepts;
- Mission design architectures;
- Spacecraft concepts;
- Cost, schedule, and risk; and,
- Identification of required new technology.

Several STDT's may be constituted to update or mature the pre-concept before a pre-concept becomes part of a program or before an Announcement of Opportunity (AO) for mission investigations/instruments is released. All STDT's are dissolved before the issuance of an AO for mission instruments, because the presence of an STDT during an instrument solicitation may be viewed as giving one investigator a competitive advantage over another. When the AO is issued, the PE is firewalled from the proposers to also avoid the appearance of giving a competitive advantage for one investigator. Thus the PE should answer no questions from proposers or participate in the development of any instrument proposals.

During the evaluation of proposals submitted in response to the AO, the PE ensures that the applicable Program Office and project for the mission support the instrument proposal evaluations led by the Program Scientist, evaluation panels, and the Science Director. This is done to gain an understanding of the cost, schedule, and technical assumptions inherent in the selections for comparison later in the project. Participation also provides the PE an assessment of the technology readiness of the instruments as well as the schedule and technology development needed to incorporate the instruments into the mission.

The PE works with the Science Director and Program Scientist for the mission to determine whether the spacecraft and instrument technology is sufficiently mature to transition the project to Formulation for Concept Definition (Phase A) at the time of instrument selection. If the technology is not sufficiently mature, the PE leads the development and coordination of an integrated technical, cost, and schedule plan to attain the maturity. This technology development is treated as mission-specific technology, and the associated costs are included in the total mission costs. If the technology is sufficiently mature, the PE prepares the applicable Formulation Authorization documentation to begin Phase A. The specific documentation varies depending upon whether or not the mission is the first project in the program and, if not, the requirements of the approved Program Plan.

7.2.3 Roadmap Development

Science Roadmaps

The goals and objectives for space science are documented in the SSE Strategic Plan, a document traceable to the NASA Strategic Plan. The

implementation strategy to support the SSE Strategic Plan is described in the SSE science roadmaps which are updated every 3 years. The science community participates in a series of workshops to update the roadmaps. The PE observes this development through interfaces with the theme Program Scientists, the Science Director and the theme technologist to gain an understanding of the emphasis for potential new programs, for future technology capability requirements, and to determine the required content for program documentation. The roadmaps are organized in a nested outline by theme, then by quest, campaign, and mission. All projects in Formulation and Implementation are included and, depending upon the consensus of the science community, missions in pre-concept definition and advanced concepts may be included. Key technology requirements are briefly mentioned in the context of their science goals.

Theme Technology Roadmap

The PE coordinates with the theme technologist to maintain oversight of the development of the SSE technology roadmap. The development of the SSE technology roadmap is led by the SSE Technology Director using the Technology Steering Group (TSG) as a coordinating forum. The theme technologists and Program Manager for the New Millennium Program are members of the TSG. This forum is also used to identify cross-mission and cross-theme technology requirements that are candidates for funding by the SSE technology activities.

7.2.4 Technology Development

The Technology Development activity supports the SSE effort to contain mission life-cycle costs and develop innovative technologies to enable new kinds of missions. SSE technology includes three major elements: Focused Technology Development, Core Technology Development, and Flight Validation. These three elements are designed to satisfy the roadmap and mission-specific technology needs unique to the SSE. Note that Technology Development spans the pre-formulation/formulation boundary, as many activities are specifically associated with technology development within existing formulated programs or projects. The Technology Readiness Level, or

TRL, is a designation that identifies the maturity, and therefore the implementation readiness, of a given technology. See Appendix E.10 for TRL descriptions.

Focused Technology Development is dedicated to high priority technologies needed for specific science missions. These technologies provide essential capabilities, without which program-specific or project-specific objectives could not be met. Development activities can range from basic research (low TRL) to technology infusion into science missions (high TRL). Focused Technologies are often identified as a result of Advanced Concept Studies, in which the technology tall poles for new roadmap missions are specified. Focused Technologies are managed by the specific program requiring use of that technology. Accordingly, any technology developed in this manner is authorized by the using program's FAD, and is subject to the authority of the program's PCA and Program Plan. PE's work closely with Program Management to ensure that the focused technology development is appropriately represented in these documents. Progress is measured against the program's implementation plan, and is reported during monthly SSE management reviews. The PE is also responsible for reviewing the program's or project's Technology Development Plan to ensure that a reasonable level of risk management has been established for the technology under development. While the PE is not a signatory on the Technology Development Plan, his/her concurrence (or lack thereof) factors into the outcome of the Mission Definition Review.

The Core Technology Development and Flight Validation elements of SSE technology are designated as Cross-Theme based on their applicability to multiple science themes and missions. Core Technology covers a broad range of fundamental (typically low to mid-TRL) capabilities that support multiple applications. Technologies within this category are advanced to the point that they are ready for infusion into a Focused program, or selected as a candidate for Flight Validation. Core technologies are generally products of the technology roadmap that have relevance across multiple SSE science themes and programs. Cross-Theme technology developments are managed separately from the programs or

projects that will eventually use them, and must therefore independently comply with NPG 7120.5 requirements for the Formulation, Approval, Implementation and Evaluation subprocesses. Core Technology Development efforts must be either initiated with a FAD, or authorized within an existing program that so allows. The PE's involved with core technology conduct periodic reviews with the participating Centers and stakeholders to evaluate progress against the implementation plans. Stakeholders typically consist of the theme scientists and representatives from projects dependent on that technology. Reviews are conducted either in person or via video or telephone conferences. Official correspondence is transmitted for corrective action in problem areas. Significant accomplishments are presented during monthly reviews to SSE management

The Flight Validation element provides a path to flight-validate key mission-enabling or enhancing technologies, thereby retiring the risk of first use for future space science missions. The New Millennium Program has been formulated to develop and flight validate mid-TRL technologies in order to facilitate technology infusion into science missions. Flight Validation activities are formulated, approved, and implemented as projects within the New Millennium Program (NMP) in accordance with the processes prescribed by the NMP Program Plan. Although Flight Validation is designated as a Cross-Theme component of SSE technology, this does not preclude other candidate technologies from consideration. Any technology validation need that has a demonstrated multi-theme or multi-mission applicability and meets the NMP criteria for TRL may be considered for Flight Validation. Technologies are selected from the SSE's technology needs inventory for NMP flight validation through a competitive peer review process. PE's who support science themes or missions requiring flight validation of a new device or concept should work closely with the theme technologist(s) to make sure that the need is accurately represented in the technology validation needs inventory.

PE's involved with technology should meet with the science theme technologists several times a year to coordinate SSE technology requirements and ensure that the technology roadmaps are consistent with and supportive of the science road-

maps. The role of the theme technologists requires them to maintain up-to-date knowledge and awareness of the technology developments and technology capability requirements throughout the Agency. They have access to Agency-wide technology inventory databases comprised of technology products and programs from a wide range of providers, including the Cross Enterprise Technology Development Program (CETDP), Small Business Innovation Research (SBIR) Program, and Agency and university-sponsored Research and Development (R&D) programs. This gives them the unique ability to offer insight into complementary development efforts that may facilitate the technology activities represented by the PE.

7.2.5 Initiation of New Programs

New Programs are proposed as funding candidates when a set of science investigations or technology capability requirements can be packaged under a common set of goals and objectives. The Program Executive supports the Science Director in developing the candidate science initiatives and leads the development of candidate technology initiatives coincident with the yearly development of the Agency's budget (that transitions into the President's budget the following winter). The SSE AA reviews the candidates and may select only some of them. For those selected, the PE supports the development of technical, cost, and schedule information, largely without input from sources outside Headquarters, because new initiatives are usually embargoed within Headquarters. The PE's requirement for support of the candidate continues if the candidate successfully passes through reviews by the Enterprise, Capital Investment Council, and the Office of Management and Budget.

7.2.6 Transition to Formulation

Formulation Authorization entails placing the definition of a newly formed program, including objectives and how it supports the SSE Strategic Plan, into a Formulation Authorization Document. The appropriate program/project assignments are made to the Lead and/or Implementing Centers via either a Program Delegation Letter or a Project Authorization Letter.

7.2.6.1 Formulation Authorization Document

The SSE AA authorizes the transition of a program from a new initiative into Formulation, and the authorization is documented in a Formulation Authorization Document (FAD). The FAD is drafted by the Program Executive and documents the purpose of the Program (that is traceable to the SSE Strategic Plan), the terms of reference, the funding, and the participants. It may be required for a new project, if the project's Program Plan so states. The authorization is independent of any particular design solution for science or technology and is stated in terms of functional capabilities. A sample FAD is shown in Appendix E.11.

7.2.6.2 Program Delegation Letter

For a new program, the signed FAD is sent to a NASA Center Director, under cover of a Program Delegation Letter issued by the SSE AA, assigning program management responsibility as Lead NASA Center. In response to this delegation, the Lead Center is instructed to respond with a proposed Program Plan for executing this responsibility, describing how the Center proposes to manage and implement the program. This letter also provides authority for establishment of a Program Office at the Lead Center.

The PE is responsible for generating the Program Delegation Letter for SSE AA signature for all new programs. The letter must have a signature block for concurrence by the Deputy Administrator of NASA, to be obtained prior to the letter being issued to the NASA Lead Center. A sample Program Delegation Letter is shown in Appendix E.12.

7.2.6.3 Project Authorization Letter

For new projects within existing programs, a Project Authorization Letter is issued by the SSE AA to the Lead Center Director for the project and to the Program Manager at the Lead Center, authorizing Phase A work on the new project to commence. A FAD will accompany this letter if one has been required. The PE is responsible for generating the Project Authorization Letter for SSE AA signature.

7.3 FORMULATION SUBPROCESS (PHASES A & B)

The responsibility for Program Formulation has been assigned to the EAA for the Space Science Enterprise, although the SSE AA delegates to others specific activities comprising the overall Formulation subprocess. Flight program responsibility is chiefly delegated to the Program Executives and Program Scientists within the OSS. The SSE AA also relies on the advice and recommendations of NASA-chartered panels and scientific advisory committees, which in many cases represent customers of the SSE.

The purpose of the Formulation subprocess is to refine mission concepts in order to define an affordable program and plan to meet mission objectives or technology goals specified in the NASA and SSE Strategic Plans. The Formulation subprocess includes developing advanced concepts, conducting trade studies, defining technology development goals, exploring implementation options, establishing internal management control functions, performing cost and performance analyses on concepts deemed to have a high degree of technical and operational feasibility, and identifying reserves associated with program risk management and other estimated project reserves.

7.3.1 Phase A Mission Requirements Definition

Phase A of Formulation concentrates on defining mission and system concepts, parameters, constraints and requirements that will allow the project to be developed on a schedule to meet established goals and within a realistic cost. It is accomplished through conduct of studies which examine the trade space permitted within identified constraints, and through continued development of enabling technology toward achieving an acceptable Technology Readiness Level. As the definition of the mission emerges from trade studies, it is important to determine, and continually adjust, the estimated cost of various components of the mission and the ultimate life cycle cost.

7.3.1.1 Mission Studies

Phase A Mission Studies are initiated by issuing a Program Delegation Letter or Project Authorization Letter to a NASA Center. The Center is asked to respond with an implementation plan. The PE reviews the Center's planned study activities, negotiates any required changes and issues a request for a NASA Form 506 budget authority from the Resources Management Division.

The purpose of Phase A Mission Studies is to determine the feasibility and desirability of a suggested new project, and to define the mission requirements and constraints prior to seeking major new funding. In this evaluation of a specific mission, the following should be defined:

- Mission & science requirements
- Project constraints and boundaries
- Alternative design concepts
- Operations and logistics concepts
- Feasibility and risk analyses
- Advanced technology requirements
- Environmental impact requirements
- Identification of needed tools & models
- Formulation Phase letters of agreement
- Detailed cost & schedule estimates
- Education & outreach possibilities

These studies need to demonstrate that credible, feasible mission designs exist within allowed budgetary cost estimates. Phase A mission studies involving new technology concentrate on technology development with a TRL of 5 or less. The phase ends with a successful Mission Definition Review or its equivalent.

7.3.1.2 External Agreements

International Agreements

With the stringent enforcement of the International Traffic in Arms Regulations (ITAR) by the United States in dealings with foreign organizations, the defining and securing of approved international agreements for work performed in conjunction with foreign partners becomes critically important to a project. The PE must work with a newly formed project in Phase A to define the content of a study phase Letter of Agreement (LOA) that will permit technical discussions between the project and its foreign partners. He/she must also determine what Memoranda of Understanding (MOU) will be needed and initiate the activities necessary to generate these, which must be approved by the U.S. State Department. An agreement in which there is an exchange of funds for services provided, known as a reimbursable agreement, requires coordination with and approval by the Office of the Chief Financial Officer (Code B). The PE tasks the Office of External Relations (Code I) to begin the process of drafting the formal agreements. The mechanism for doing this is an entry into the on-line Space Science Pending International Agreements Database (SSPIAD), which is a task database jointly maintained between OSS and Code I.

Interagency Domestic Agreements

Partnerships with other agencies may be documented in a Memorandum of Agreement (MOA). MOA's are typically done for major collaborations or when there is any reimbursement for a service performed. If the Department of Defense is involved, the PE must coordinate with the Director of Assessments and Technology (Code ID). The PE, with advice from relevant Headquarters support offices, including Office of the General Counsel, and support from the project, negotiates the collaborative agreement. No external approvals, such as from the State Department, are required for domestic agreements. The cooperative agreement is signed by the involved Enterprise AA's. A reimbursable agreement requires coordination with and approval by Code B. It is not always necessary to have a formulation MOA done for domestic collaborations, as for foreign collaborations, because technology transfer and cross waiver of liability are not issues. However, if it is a major collaboration, with significant contributions from the other agency needed for the successful implementation of the mission, a formulation MOA is highly desirable to ensure both agencies are in early agreement on the collaboration. MOA's are to be drafted and ready for signature by the time the project is ready to seek approval to enter Implementation.

7.3.1.3 Initiation of Program Commitment Documentation

During Phase A of Formulation, program-level requirements are determined and drafted. Program-level requirements are those requirements levied by the Enterprise (defined as Level 1) on the Lead Center, which the project will use to generate lower level requirements to be implemented. NASA Headquarters will use these program-level requirements to evaluate the performance of the project during implementation. For single-project programs, these requirements will ultimately be inserted into the Program Plan. For new projects in multi-project programs, the requirements will be attached to the Program Plan as a project-specific appendix. Program-level requirements on the multi-project program itself will be documented in the body of the Program Plan. The PE is responsible for generating this material through coordination with the Program Scientist, the Science Director, the Principal Investigator and the Program Office and project at the Center.

For new programs, the Program Plan and Program Commitment Agreement also need to be started in this phase. The PCA will contain the subset of the Level 1 requirements that define the commitment for the program between the Enterprise AA and the Administrator, and can be considered Level 0 requirements. New projects should begin their project plans in Phase A.

7.3.1.4 Mission Definition Review

The project review that marks the end of Phase A and the beginning of the transition to Phase B is the Mission Definition Review (MDR), as defined by the NASA Systems Engineering Handbook (SP-6105). This review obtains preliminary agreement on mission definition parameters. For both flight and ground components, it covers the preliminary requirements at levels 1 and 2, preliminary mission design, very preliminary systems design with margins, procurement strategy, operations concept, significant risks and mitigation strategies, a preliminary schedule and initial life cycle costs estimates. This review, or its equivalent, must be successfully accomplished before a transition from Phase A to Phase B of Formulation can be accomplished through an Initial Confirmation Review with the SSE AA. If a Confirmation Assessment board has been chartered, they may participate in the MDR.

7.3.2 Phase A to B Transition

The Program Executive coordinates the development of required program and project documentation with the Center. Through reviews of the project conducted during Phase A and reviews of project documentation, the PE assesses whether or not the project has completed the Phase A objectives and continues to indicate a viable development within the anticipated cost and schedule. If, through this analysis, and after coordination with the Science Director and Program Scientist, the PE determines the project is not ready, he/she will direct the project back to the Center for further Phase A formulation.

With a decision to proceed, the PE initiates and coordinates the Phase A-to-B confirmation activity. This generally will consist of a Confirmation Assessment (CA) by an independent review board, a Center-organized Confirmation Readiness Review (CRR) for the Center Program Management Council (PMC), and finally, an Initial Confirmation Review (ICR) with the SSE AA. The PE coordinates establishment of the CA board and its review charter with the project. The CA board will attend the MDR and hold discussions with the project as necessary, in order to assess whether or not the project has completed the Phase A objectives and is ready to proceed to Phase B. The board will make its recommendation first to the project and the Center PMC.

The PE schedules the ICR on the SSE AA's calendar and ensures all presenters can support it. At the ICR itself, the project presents the results of the CRR and the recommendations of the Center PMC. The chair of the CA presents the board's findings and recommendations. The SSE AA and the Science Board of Directors hear the recommendations and assess the prospect of the mission being able to meet the science objectives on schedule and within budget. With a positive decision by the SSE AA, and if all required documentation is complete, the project is confirmed for Phase B. Authorization to proceed is subsequently issued in a confirmation letter drafted by the PE for SSE AA signature. A "No Confirma-

tion" decision by the SSE AA can direct the project back to the Center for further Phase A Formulation or it can terminate any further effort.

This transition occurs in the middle of the Formulation subprocess and is partially dependent on the readiness level of the technology needed for implementation of the project. For projects that contain significant technology requirements, OSS prefers to have a longer Phase A to ensure technology readiness before a project enters Phase B. This is to reduce the overall risk to the project affecting cost, schedule, and technical performance inherent with unproven technologies.

7.3.2.1 Phase A to B Transition Point for New Technology

All projects will be subject to a Phase B Initial Confirmation Review by the SSE AA. At this time, they will be required to demonstrate that no major outstanding technology readiness issues remain, otherwise they will not receive approval to enter Phase B. Likewise, small and mid-size missions that require an ICR to enter Phase B, including domestic and international collaborations where NASA is participating in a non-NASA led mission, are also required to demonstrate that they have no major outstanding technology readiness issues. Based upon the results of Lead Center and partner reviews, and if missions requiring enabling technology have that technology at a TRL of 5 or higher, the project may enter Phase B. This TRL restriction does not necessarily apply to technology flight demonstrations.

Flight Validation projects, such as those of the New Millennium Program may allow a different transition TRL than other projects because of their technology demonstration focus. Unlike science focused missions, technology development of TRL 5 or lower may occur during Phase B, but the project must successfully pass TRL 5 as part of the requirements to move to Implementation, which must be accomplished in Phase B. Because a NMP mission may be the validation of a technology in a relevant environment, unlike other projects, it may not have achieved TRL 6 by the time of the Non-Advocate Review or Phase C Confirmation Review.

7.3.2.2 Programmatic Requirements for Phase A to B Transition

For all projects, the Program Executive is responsible for ensuring that the following tasks are completed during Phase A before the start of Phase B can be approved. While the PE is responsible for ensuring accomplishment, most of these tasks must involve significant input from the Program Scientist, the Science Director, the Program Analyst, and the program/project at the Center. The first five are actually led by the Program Scientist or Science Director.

Tasks led by Scientists with support from PE:

1. Determine whether it is a Principal Investigator (PI) or facility-class mission.
2. Issue an AO and select instruments, the PI and science teams.
3. Establish policies for forming the science teams and their participation.
4. Establish location and responsibility for the science data center.
5. Begin development of policy guidelines for data rights, access to data, and funding for Guest Observers.

Tasks led by PE with support from others:

6. Establish preliminary budget cap for project.
7. Develop performance metrics for Phase B.
8. Develop a plan for independent assessments.
9. Draft program-level requirements for inclusion in Program Plan.
10. For projects, write Program-Level Requirements in the project-specific Appendix to the Program Plan.
11. Ensure that all enabling technology required has reached a TRL of at least 6 (except for NMP).
12. Organize Phase B Confirmation Assessment board, develop charter, ensure review is conducted and findings are presented to project, Center PMC and OSS.
13. Write JPL Phase B task plan, if applicable.
14. Identify need for environmental assessment or impact studies.

15. Write study phase letters of agreement (LOA) for non-NASA domestic and international partners.

16. Establish and document understanding of collaborations with partners, as a basis for writing the MOU's and MOA's for non-NASA partners (domestic and international).

<u>Tasks led by Center under PE oversight:</u>

17. Develop estimates of life cycle costs for the mission (through Phase E, including tracking).

18. Complete Phase A systems trades and optimization studies with appropriate documentation.

19. Develop guidelines for mission operations: flight, ground, and science, and preliminary Operations Concept.

20. Draft the Program Plan.

21. Finalize launch vehicle performance requirements.

22. Identify telemetry, tracking and commanding requirements and strategy.

23. Draft preliminary environmental assessment or environmental impact study reports.

24. Identify areas of anticipated risk and define risk mitigation strategies.

25. Develop an acquisition strategy (if required) and obtain NASA Headquarters approval.

26. Prepare contracts for issuance to start Phase B work.

27. Establish preliminary document tree.

28. Develop a draft education and public outreach plan to utilize 1 to 2% of the project budget, in concert with program-level plans.

7.3.3 Phase B Preliminary Design

Phase B of Formulation concentrates on applying results of mission studies and trades completed in Phase A to generate preliminary mission, instrument and spacecraft designs that satisfy the identified constraints and requirements, and that will allow the mission to be developed on a schedule to meet established goals within a budgeted cost. It is a time for finalization of the requirements and establishment of the cost caps that will become firm requirements at confirmation. Costs that should be detailed in Phase B, whether or not they are a part of the controlled cost cap, include the usual spacecraft development and test activities, and also launch vehicles, external reviews, full mission operations (including tracking requirements and Space Operations Management Office (SOMO) costs), and data analysis, including data archiving and science center operations. Schedules are defined that will allow mission and spacecraft development to meet the desired launch date with adequate margin. Risks are identified and risk mitigation plans developed.

7.3.3.1 Project Reviews

Various projects may call for different system-level reviews during Phase B, according to differing Center policies. There are two that support the space science program structure presented in Subsection 2.2.4 of this handbook and are consistent with good engineering practice. The first of these is the Systems Requirements Review (SRR), which evaluates the completeness, consistency, and achievability of mission, system, subsystem and assembly requirements necessary to fulfill the mission objectives and requirements, and the traceability of the requirements flowdown. The SRR should occur early in Phase B and should cover mission, project, science, operational, flight system and ground system requirements. (Some projects may choose to combine the SRR with the MDR at the end of Phase A.)

The project review that marks the end of Formulation Phase B and starts the transition process to Implementation Phase C is the Preliminary Design Review (PDR). The PDR assesses the compliance of the preliminary design against the applicable requirements and evaluates the readiness of the project, system, subsystem or assembly to proceed with detailed design.

7.3.3.2 Policy Decisions/Actions Made by NASA Headquarters During Phase B.

While there are many activities performed by the project at the Center during Phase B leading to a mission preliminary design, the purpose of this handbook is not to describe what occurs at the Center, but to describe what the Headquarters Program Executive should be doing during this timeframe. The next several subsections (through 7.4) describe much of what needs to be done, par-

ticularly in the way of documentation, review support, program/project assessment and the process of approval to achieve transition to Implementation. All of this requires significant work by the PE in Phase B. However, there are certain key decisions and actions that the PE needs to make in Phase B to enable the process to efficiently play out. These are as follows:

- Decide which of the requirements need to be placed into the Program Commitment Agreement (PCA).

- Decide what mission cancellation criteria are to be placed into the PCA.

- Determine and obtain agreement on a firm cost cap for project, which is a program-level requirement.

- Decide what technology can be used for the project, based on critical need, TRL and mission criticality.

- Select final launch vehicle and work with Code M to get the mission onto the manifest.

- Decide whether an environmental assessment (EA) or environmental impact statement (EIS) is required, based on Phase A studies.

- Initiate establishment of the ad-hoc Interagency Nuclear Safety Panel, if required.

- Decide if risk mitigation plans are sufficient for the mission as planned, and if not, investigate actions to modify.

- Decide with Code I, or other agencies as appropriate, on the external agreement mechanism (LOA vs MOU vs MOA) and how many are required.

- Determine the number of and mechanisms for interagency agreements.

- Decide on telemetry, command and tracking needs, i.e., DSN versus TDRSS versus independent ground stations.

- Decide on necessary independent reviews, e.g., need for an EIRR.

- Determine if planetary protection work will be required.

- With the Program Scientist, develop data archiving policies.

- Decide if project education and outreach activity will be done at the project or program level and if cross-program activity will be supported.

7.3.3.3 Preparation for Approval (NAR or CA)

For a single-project program, or a project of sufficient cost or visibility, NASA will require a Non-Advocate Review (NAR), chartered by the NASA Chief Engineer's Office. In this case, the PE will need to work with that office and with the project to choose the membership of the NAR board, and to schedule meetings with the project prior to an approval meeting with the NASA Headquarters PMC (chaired by the Associate Deputy Administrator). This is the full NPG 7120.5 process. The NAR role in Approval for Implementation is discussed in Subsection 7.4.

For smaller projects that do not report to the NASA Headquarters PMC, the PE must work with the project to organize and conduct the Confirmation Process, which is a 7120-tailored substitute for the NAR for space science projects. In preparation, the PE coordinates the development of required project documentation with the Center. Through reviews of the project conducted during Phase B and reviews of project documentation, the PE assesses whether or not the project has completed the Formulation objectives and continues to indicate a viable development within the anticipated cost and schedule, to the point of readiness to begin detailed design. If, through this analysis, and after coordination with the Science Director and Program Scientist, the PE determines the project is not ready, he/she will direct the project back to the Center for further Formulation.

With a positive decision, the PE initiates and coordinates the Confirmation activity. This generally will consist of a Confirmation Assessment by an independent review board, a Center-organized Confirmation Readiness Review (CRR) for the Center PMC, and finally, a Confirmation Review with the SSE AA. The PE coordinates establishment of the CA board and its review charter with the project. The CA board will attend the PDR and hold discussions with the project as necessary, in order to assess whether or not the project has completed Formulation objectives and is ready to proceed Implementation. This process is further detailed in Subsection 7.4.

7.3.3.4 *Completion of Formulation Documentation*

Phase B of Formulation is the time for generation of key program commitment documents at both the program and project level. Detailed instructions to the PE for preparation of these documents are given in the next subsection.

7.3.4 Program Commitment Documentation

The Program Commitment Agreement is the agreement between the NASA Administrator and the EAA that documents NASA's commitment to execute the program requirements within established constraints. The Program Plan is the agreement between the EAA, the Center Director and Program Manager that relays this commitment to the NASA Center. These documents ensure that NASA Headquarters and all supporting organizations understand the programmatic, technical, and management systems requirements and commit to providing the necessary resources.

7.3.4.1 *Program Commitment Agreement*

Baseline Program Commitment Agreements (PCA's) are written in Formulation, as defined in Subsection 2.1 of NPG 7120.5. They are drafted when the first project in the program is in Phase A and finalized when it nears the end of Formulation Phase B. The PCA approval process occurs during the program Approval phase, which occurs simultaneously with approval for the first project in a multi-project program. An approved PCA is required for approval of the first project for Implementation, as defined in Subsection 2.2 of NPG 7120.5. PCA's are subject to annual revision, review, and revalidation. Required PCA content is defined in Appendix E-2 of NPG 7120.5. In the PCA, program requirements for a single-project program include, as appropriate: number of instruments, instrument and/or telescope performance, orbit, lifetime, and calls for proposals. The program requirements for a multiple-project program (a mission series, for example, Discovery) address the program, rather than the individual projects. The requirements include items such as how often AO's are released, how new projects are managed, how they report, length of development time, and requirements for approval by Confirmation Review. The PCA is tai-

lored to reflect the uniqueness of each program. Tailoring identifies the process and requirements that have been revised and identifies the unique approaches to be approved by management.

The PE is the person responsible for developing the PCA, although he/she should consult with the Science Director or Program Scientist, as applicable, and may receive help from the Program Manager at the Center. The flow of activities involved in the development of a PCA is given in Office Work Instruction HOWI7120-S006. This work instruction is the authoritative instruction for performance of this task. To ensure use of the most current OWI, always check: http://www.hq.nasa.gov/hqiso9000/library.htm.

During early Formulation, the PE prepares the initial draft of the PCA from cost, schedule, and program objective information received from the implementing Center, working closely with the Program Scientist. The Program Operating Plan, prepared annually by the Lead Center, and the Program-Level Requirements provide reference material for the PCA. The PE coordinates a review of the draft PCA among key elements within OSS (e.g., the Program Scientist, the Program Analyst, the Science Director, and others as appropriate for the content of the specific PCA). With input from the project at the Lead Center, the PE modifies the PCA in accordance with comments and inputs received and ensures that the PCA format satisfies the requirements specified in Appendix E of NPG 7120.5.

The PE negotiates concurrence on the Program Cost Commitment chart with the Office of the Chief Financial Officer (Code B), the Office of Space Flight (Code M) for tracking and SOMO services, and others as appropriate for the content of the specific PCA. After this is done, the PE submits the coordinated draft PCA to the Office of the Chief Engineer (Code AE), which responds with comments and requests for revision.

As the program (or first project) approaches the Approval milestone, the final PCA is generated as an input to the NAR process. This final PCA is submitted for approval by the SSE AA, concurrence by the NASA Headquarters Office of the Chief Engineer, and signature by the NASA Administrator. Annual review of the PCA, with updates as necessary, is required after the Presi-

dent's budget is released in the spring of each year. There are two types of changes. Major changes represent significant impacts to requirements, schedule, resources, risks, or agreements and must be approved by the Administrator. All other changes are minor and can be approved by the Associate Deputy Administrator. The SSE AA will classify proposed PCA changes as either major or minor.

7.3.4.2 Program Plan and Program-Level Requirements Appendix

A Program Plan is prepared during the Formulation subprocess of a program, and is signed when the program receives approval from both OSS and the NASA HQ PMC to proceed to the Implementation subprocess, as defined in Subsection 2.2 of NPG 7120.5.

For projects in multi-project programs, a Program-Level Requirements Appendix to an existing Program Plan is prepared during Formulation. It should be drafted in Phase A of Formulation, and be carefully coordinated with all stakeholders such that these top-level requirements are well understood and are specific enough to allow flow-down to lower-level project requirements and subsequent traceability between levels. This appendix is signed by the SSE AA when the project receives approval to proceed to the Implementation sub-process, as defined in Subsection 3.2 of NPG 7120.5. All the necessary precursor signatures and concurrences must be obtained in Phase B, well in advance of the approval meeting, whether it is a Confirmation Review or a NAR presentation to the HQ PMC. An example generic Program-Level Requirements Appendix (developed for the Explorer Program) is attached as Appendix E.9 to this document.

Program Plans and Program-Level Requirements Appendices are generally not revised after signature. However, if necessary, modifications may be made and documented in a revision to the Program Plan or Program-Level Requirements Appendix if approved by the applicable Science Director and the SSE AA.

A single-project program will have a single document Program Plan containing all the top-level requirements on the program. A multi-project program will have a Program Plan with

sections specifying the overall requirements on the program and providing general program policies, and a separate Program-Level Requirements Appendix for each project within the program. Mission series projects within a program may be initiated through an AO selection or via the strategic plan roadmap process.

The single-project Program Plan or the Program-Level Requirements Appendix identifies the mission, science and programmatic requirements (funding and schedule) imposed on the project. It covers project-unique policies, and specifies requirements on science data collection, mission and spacecraft performance, budget, schedule, launch vehicle, and any other requirements at Level 1. It identifies the responsible implementing organization for the development and operation of the project. A sectional outline for a Program Plan, with brief description of each section, is contained in NPG 7120.5. The emphasis in the Program Plan for multi-project programs is on requirements levied on the overall program. The emphasis in the Program-Level Requirements Appendix is on the mission-unique requirements, and should not repeat the program-level requirements already contained in the Program Plan. This document will also discuss the risk management approach and process and the use of descope plans.

This document also serves as the basis for project assessments conducted by NASA Headquarters SSE officials during the development period, and provides the baseline for the determination of the science mission success following the completion of the operational phase.

The Program Office has the overall responsibility for meeting the mission, science, cost and schedule requirements contained in the Program Plan or Appendix. The Program Office delegates to the specific Project Managers all or part of this responsibility. The project is then responsible for all design, development, test, launch and mission operations, and data verification tasks that implement the mission, and coordinates the work of all contractors and science investigators. Changes to program-level requirements require approval by the Office of Space Science.

The Program Plan or Program-Level Requirements Appendix identifies, either explicitly

or by reference, any NPG 7120.5 requirements or processes which the project/program does not plan to implement or is substantially modifying. Approval of such tailoring changes is obtained through signature on the Program Plan. Such tailoring of NPG 7120.5 requirements is further documented in Project Plans and lower level documents, or if Center processes allow, in internally controlled project documents. Program-level tailoring of NPG 7120.5 requirements is not necessarily repeated in the Program-Level Requirements Appendix.

The flow of activities involved in the development of a Program Plan or Program-Level Requirements Appendix is given in Office Work Instruction HOWI7120-S005. This work instruction is the authoritative instruction for performance of this task. Always check this web address: http://www.hq.nasa.gov/hqiso9000/library.htm to ensure use of the most current OWI.

The PE works with the Program Scientist and the Program or Project Manager to generate the program-level requirements during Phase A of Formulation. If the mission was selected via an Announcement of Opportunity (AO), the draft program-level requirements are extracted from the winning proposal. If the mission was not selected via an AO, the draft program-level requirements are extracted from other relevant sources (e.g., instrument capabilities, mission concept studies, or non-NASA documents if it is a cooperative mission).

The PE negotiates the program-level requirements with personnel at the relevant NASA Headquarters offices and NASA Centers, including the Program Scientist, Science Director, and Program and Project Managers. Others may include the Project Scientist, the implementing organization (if other than the Lead Center), Principal Investigator(s), OSS Policy Analyst, non-NASA partners, the NASA Headquarters tracking office, and the NASA Headquarters launch vehicle provider organization in Code M. When an informal consensus is reached on the content of the program-level requirements, negotiations are completed.

If the requirements are for a program, the Program Manager incorporates the negotiated Level 1 requirements into the draft Program Plan

that was requested by the Program Delegation Letter, which follows the content requirements identified in Appendix E-3 of NPG 7120.5. After the PE and the Program Manager agree on the content of the Program Plan, the Program Manager obtains the appropriate signatures at the NASA Center and submits the plan to the PE, who then obtains approval by the SSE AA.

If the requirements are for a project, the PE is responsible for creating a draft Program-Level Requirements Appendix to the relevant Program Plan, incorporating the negotiated Level 1 project requirements. The PE must include the content identified in Appendix E-3 of 7120.5, coordinating specific content with whomever necessary to ensure capturing a clear and complete set of requirements at Level 1. After the PE and both the Program and Project Managers agree on the Program-Level Requirements Appendix, the Project Manager obtains the appropriate signatures at the NASA Center and other relevant organizations, and submits the plan to the PE, who then obtains approval by the SSE AA.

The Program Plan or Program-Level Requirements Appendix is reviewed on an annual basis, but updated only if needed. If the changes do not affect the program-level requirements themselves, concurrence only needs to be obtained at NASA Headquarters from the Program Executive, Program Scientist, cognizant Science Director and others as appropriate to the nature of the change. If the changes involve changing the program-level requirements, in addition to the above concurrence the SSE AA and Center Director, or their representatives, must re-sign the document signifying approval.

7.3.5 Program/Project Assessment & Reporting

7.3.5.1 Program Management Councils

NASA has established a hierarchy of Program Management Councils (PMC's), as illustrated in Figure 7.3-1, to ensure appropriate levels of management oversight. The Agency PMC at NASA HQ is responsible for evaluating proposals for new programs, for providing approval recommendations to the Administrator, and for assessing existing programs to evaluate cost, schedule, and

technical content to ensure that NASA is meeting its commitments. The NASA HQ PMC is supported in this task by the Office of the Chief Engineer, assisted by other organizations such as the PMC Working Group and the Independent Program Assessment Office (IPAO) at LaRC.
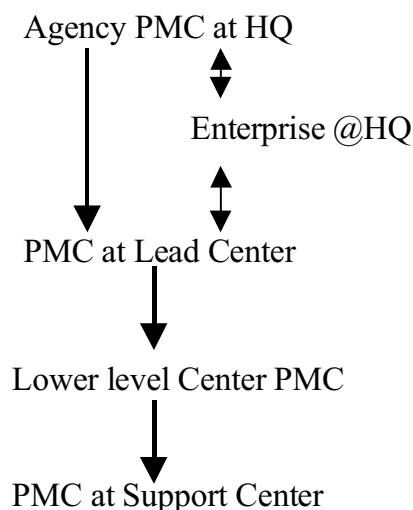
Agency PMC at HQ

Enterprise @HQ

PMC at Lead Center

Lower level Center PMC

PMC at Support Center

Figure 7.3-1 Hierarchy of PMCs

Other PMC's are established at the Lead Center and supporting NASA Centers, and at lower levels within each Center as required. Similar to the NASA HQ PMC, these councils evaluate the cost, schedule, and technical content to ensure that NASA is meeting the commitments specified in the PCA, the Program Plan, and the Project Plan. The "governing" Program Management Council for a specific project is the highest level PMC that regularly reviews that given project. In general, new programs begin to report to the NASA HQ PMC as "governing" when their first project reaches Phase B. All programs continue to report to the NASA HQ PMC unless delegated to a lower level PMC. For projects, the SSE recommends to the NASA HQ PMC the location of the governing PMC. Usually, the first (or only) project is recommended for NASA HQ PMC as governing and the remaining projects recommended at the Center PMC. However, the NASA HQ PMC may delegate or elevate governing status as it sees fit. The SSE interfaces closely with both the NASA HQ PMC and the Lead Center PMC.

Various independent performance assessments are conducted by external teams and reported to the governing PMC. The types of independent assessments performed within the SSE and reported to the NASA HQ PMC are the External Independent Readiness Review (EIRR), Independent Assessment (IA), and CA or NAR. They are fully described under Evaluation (in Subsection 7.6) and will not be addressed here. Also, most projects have a standing review board, chartered by the Center, that performs independent assessment and reports to the Center PMC.

7.3.5.3 Enterprise Review and Reporting

Monthly Reviews

While the SSE doesn't convene a PMC, there are monthly reviews at the SSE level with the Deputy AA and the SSE AA. To meet these monthly, quarterly and annual oversight requirements, the SSE assesses program and project progress and performance against the program-level requirements, cost plan, and development schedule. The flow of activities involved in the Program/Project Assessment process is given in Office Work Instruction HOWI7120-S007. This work instruction is the authoritative instruction for performance of this task. To ensure use of the most current OWI, always check http://www.hq.nasa.gov/hqiso9000/library.htm.

In normal project reporting, the PE receives monthly status and progress reports from Program Office or project. These are accomplished either through visits to the project, videoconferences, or telecons. Presentation material is often in electronic form and placed onto the OSSIM (OSS Information Management) file server. The PE then creates monthly project assessment reports for electronic presentation to SSE management, and installs these reports on the OSSIM server. The initial presentation is by each PE to the Deputy AA and cognizant Science Director at the Flight Program Monthly Review, which is closed to non-Headquarters people. This is followed by the SSE Monthly Review to the SSE AA. The Science Directors and Division Directors make this latter presentation, using information provided by the PE. Information presented at the SSE Monthly Review is more summary in nature, because of the shorter length of the meeting and its open nature.

The PE performs ad hoc assessment and reporting whenever necessary to SSE management for programs or projects that are projected to have high development costs, have unusually high public or NASA visibility, or have other unique features. This reporting often falls outside the normally scheduled cycle.

Weekly Reporting

For projects that have passed the Critical Design Review (CDR) milestone, the Program Executive tasks the project to submit short weekly status reports via the OSS Internet-based reporting system. These reports capture at a very brief level the most significant project accomplishments for the previous week. The PE edits the report as necessary, adding Headquarters-unique information as appropriate. The Flight Programs Division Director finalizes the OSS Weekly Report as a compilation of the individual status reports, and archives the Weekly Report on the OSS server for SSE management access.

Quarterly Status Reports to the HQ PMC

If the program or project is subject to review by the NASA HQ PMC, the Flight Programs Division Director works with the Program Executives and the Program Analysts in the Resources Management Division to prepare the Quarterly Status Report (QSR) for electronic presentation to the NASA HQ PMC. The presentation is made by the Division Director or designee, on a schedule established by the Chief Engineer's Office.

Annual Theme Review

Each Science Director is required to present an annual State of the Theme report to the SSE AA. This report and presentation reviews progress against the theme's portion of the SSE Strategic Plan in the past year and its plans for progress in the next year. The presentation includes descriptions of all missions and programs in Formulation and Implementation, missions in operations and extended operations, missions in advanced concepts, technology development progress and plans, budget, and schedule. The Program Executives support the development of the presentation material and work with the Resource Analysts to ensure that content, budgets, and schedules coincide with releasable (and not embargoed) budget and schedule information.

GPRA Metrics

The SSE is required to submit performance metrics and narratives, in response to the Government Performance and Reporting Act (GPRA), to support the proposed new budget for the fiscal year commencing two years hence and the Operating Plan for the coming fiscal year. The PE provides technical information, and schedule and performance milestones, to the appropriate Resource Analyst to support this activity and coordinates the reporting on performance metrics for the past and current fiscal years, supplying performance reports to the AAA for Strategic and International Planning.

Budget Support

The Centers submit a Program Operating Plan yearly to describe their budget requirements for the coming fiscal year. Their submission is based upon instructions and guidelines issued by OSS. The PE supports the development of these instructions and guidelines by coordinating the development of them with the Resource Analyst, the Science Director, the Division Directors and the other PE's working on missions or projects in a theme's programs.

7.3.6 Formulation Checklist

During the Formulation Phase, the following information and decisions are developed and documented. Some of these were discussed in previous subsections, while others are mentioned only here, but all are placed here to provide a checklist for the Program Executive of what needs to be accomplished during Formulation. Some of these products are generated by projects at Centers and provided to Headquarters for approval, but all need to be addressed for successful approval to enter Implementation.

The products of Formulation (Phase B to C Transition) are:

1. Determination of the level of governing Program Management Council assuming responsibility for program oversight.

2. A proposed Program Commitment Agreement for new programs, or proposed updates to an approved PCA for new projects, showing funding profile and top-level schedule milestones.

3. A Program Plan containing program requirements (for new programs), and Level 1 appendices with program-level requirements for new projects, including budget cap, risk management, and performance metrics for Phases C/D/E.

4. Project Plans ready for approval.

5. Science instruments selected and PI's/Co-I's identified.

6. Agreement between the Program/Project Manager and the NASA Headquarters Program Executive on program reporting: method, content, and frequency during Implementation.

7. Definition of Launch Vehicle requirements for NASA or non-NASA Expendables (ELV) or Space Shuttle (STS), including secondary payloads, and draft manifest request. (e.g. Form 1628 for STS).

8. Deep Space Network (DSN) requirements, if applicable, along with associated costs for transfer to OSS.

9. A proposed Space Operations Service Level Agreement (SLA) with the Space Operations Management Office (SOMO).

10. Approved Technology Development Plan, which includes identification of required enabling technology and a verification of its maturation beyond TRL 6 (except for NMP).

11. An approved acquisition plan.

12. Signed Formulation Phase Letters of Agreement (LOA) with other NASA and non-NASA organizations whose support is required to achieve program objectives.

13. Draft Implementation-Phase LOA's with other NASA and non-NASA organizations, if required.

14. Final drafts of proposed Memoranda of Understanding (MOU) or Memoranda of Agreement (MOA) for domestic and international partners, which may be required.

15. Risk Management Plan, documenting a thorough assessment of technical, cost, and schedule risks. (See Subsection 4.2 of NPG 7120.5.)

16. Descope Plans, for implementation in the event of cost or technical difficulties.

17. Plan for independent reviews during Implementation.

18. Non-Advocate Review (NAR) or Confirmation Assessment (CA) results.

19. Cancellation review criteria. (Generally specified in the PCA for projects in the program.)

20. Draft National Environmental Policy Act (NEPA) compliance documentation. (See Subsection 7.5.2.)

21. Draft Orbital Debris Assessment.

22. Draft schedule for Nuclear Launch Safety Approval, if required. (See Subsection 7.5.2.)

23. Notices of Intent for environmental impact. Start environmental assessment process (and planetary protection), if required.

24. Project-level education and public outreach plans to be approved by NASA Headquarters (may be part of the Project Appendix).

25. MO&DA budgets, agreed to by the Program Scientist, Science Director and Division Directors of Codes SR and SD.

26. Guidelines for Mission Operations.

27. Draft Mission Data Management Plan, including data archiving and data rights policies.

28. Draft plan for a Science Data Center, if applicable. (See Subsection 6.2.4)

7.4 APPROVAL SUBPROCESS (PHASE B TO C TRANSITION)

The purpose of the Approval subprocess is to decide whether a project is ready to proceed from Formulation to Implementation, and if so, to effect that transition. The details of the subprocess vary depending upon whether the project is a single-project program or part of a mission series. Mission series programs include the AO-initiated projects such as the Discovery and Explorer programs, and the Roadmap-initiated projects such as the New Millennium and Solar-Terrestrial Probes programs. Some of the reviews mentioned below can appropriately be considered part of the Evaluation subprocess (Subsection 7.6) occurring during Formulation, but are also listed here to help clarify the "Approval" flow.

There are two paths to approval. One is the regular NPG 7120.5 process through the NASA

HQ PMC, a path followed by programs or projects where the governing PMC is the HQ PMC. The second is a 7120-tailored process that achieves approval through a Confirmation Review with the SSE AA. This is the path for projects where the governing PMC is the Center PMC.

All the items on the Formulation checklist in Subsection 7.3.6 should be completed prior to the Approval meeting, but in particular, the approval authority will not approve without a signed Program Plan and/or Program-Level Requirements Appendix and a Program Commitment Agreement either signed or ready to sign. The status of any of the other items on the checklist is subject to being examined for completeness. If not complete, approval may not be given or be conditional.

7.4.1 Approval for Single-Project Programs

For single-project programs and those projects that have been elevated to the NASA HQ PMC, this subprocess involves a set of steps leading to a decision whether or not the project is ready to proceed from Formulation to Implementation, and if so, to then gain the NASA Administrator's approval for implementation of the new program and/or project. If the meeting is for a project within an existing program, the PMC will expect an updated PCA including the new project.

As defined in the proposed PCA and Program Plan, a Non-Advocate Review (NAR) is conducted as a part of the Evaluation subprocess during Formulation. The proposed PCA is coordinated with the PMC Executive Secretary (within the NASA Chief Engineer's Office) to ensure consistency on content and format. The Program Plan is written by the Program Manager, and approved by the Lead Center Director and the SSE AA, including the securing of required concurrences. The Program Executive, with concurrence of the Deputy Associate Administrator for Space Science, the Program Manager and the Flight Programs Division Director, works with the NASA Chief Engineer's Office to schedule the NASA PMC, at which approval to enter Implementation for this program is sought.

At the PMC meeting, the Program Manager presents a summary of the program or project, including topics in the Program Plan. A summary

of the Risk Management Plan, including a Descope Plan, is presented. The results and findings of the NAR are also conveyed by the NAR chairperson. The SSE makes its recommendation to the PMC. If the PMC recommends transition to Implementation, this recommendation goes forward to the NASA Administrator with the proposed PCA.

A PCA signing meeting with the NASA Administrator is arranged by the PMC Executive Secretary after the NAR presentation to the PMC. Approval by the NASA Administrator is conveyed to the SSE AA and is reflected in his signature, along with that of the SSE AA, on the PCA.

With the NASA Administrator's approval, the SSE AA then authorizes the transition of the program to Implementation, and the Resources Management Division is notified to release the corresponding funding to the project per the approved budget plan. The signed PCA and the Program Plan form the baseline for the Implementation subprocess. The process flow for the program approval process is depicted in Figure 7.4-1.

If the PMC does not recommend transition to Implementation, or if the NASA Administrator does not approve the transition, the program or project returns to the Formulation subprocess, addressing whatever deficiencies are identified as the rationale for not proceeding to Implementation. Changes in budget or in strategic plan criteria used to approve the program/project, or changes within the program/project that violate the original approval criteria, could necessitate reformulation and reevaluation for re-baselining or termination.

7.4.2 Approval for Projects in a Mission Series

The subprocess for projects in a mission series involves a set of steps leading to a Confirmation Review with the SSE AA to decide whether to proceed from Formulation to Implementation. This includes science community-initiated projects selected via response to a competitive Announcement of Opportunity, specifically from the Discovery and Explorer Programs, and those projects of a mission series initiated by NASA from theme roadmaps, including projects in the Mars
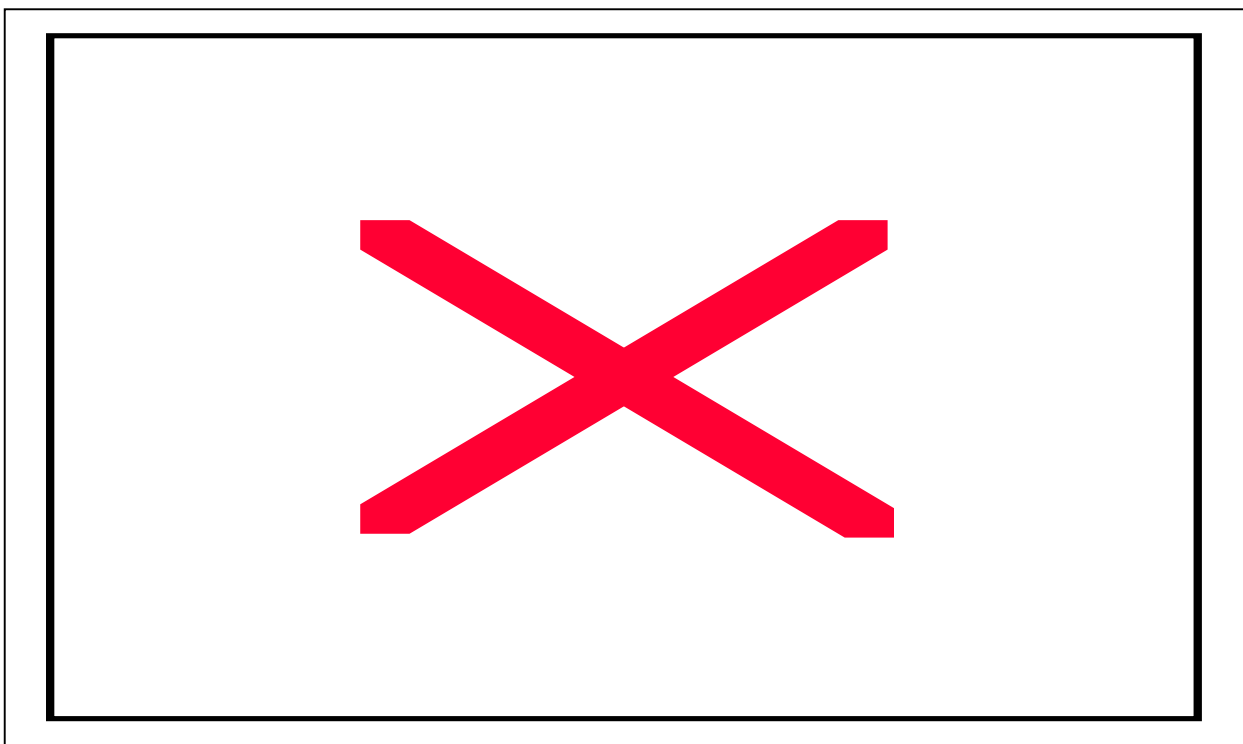
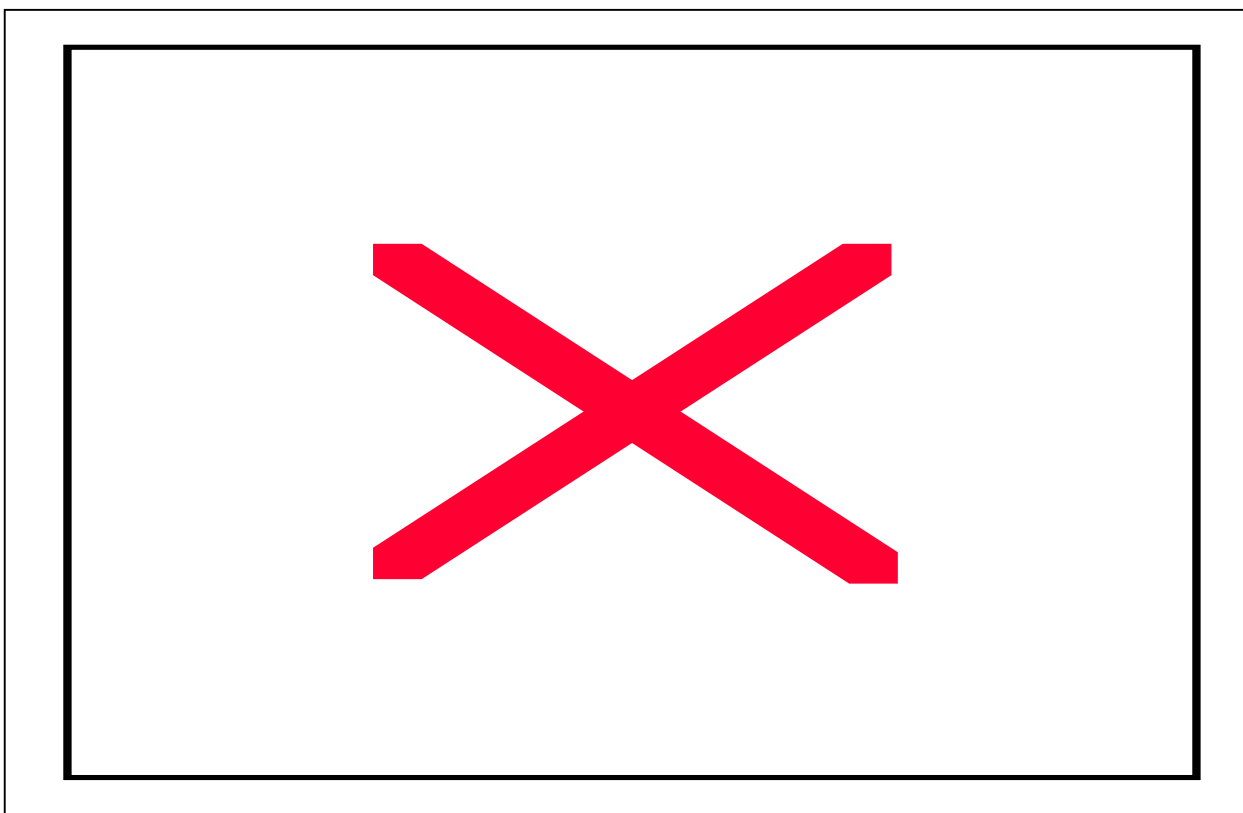*Figure 7.4-1 Program Formulation Process Flow*

Figure 7.4-2 AO- and Roadmap-Initiated Project Formulation Process Flow

Surveyor, New Millennium, and Solar Terrestrial Probes programs. Figure 7.4-2 illustrates the process flow for AO- and Roadmap-Initiated projects.

The NASA HQ PMC may, at its discretion, select a project to undergo an Independent Assessment (IA). If so, the IA would have been conducted during Phase A by the LaRC IPAO to provide validation of the technical approach and cost analysis. Results of an IA, if conducted, are reported to the project and then to the SSE AA, and may be required to report to the NASA HQ PMC. Evidence of the project having addressed IA actions will likely need to be presented to gain confirmation.

During the Formulation subprocess, project teams plan normal design and programmatic reviews to allow the implementing Center or organization to judge project readiness to proceed to Implementation. The reviews typically involve a technical design readiness aspect (e.g., a Preliminary Design Review - PDR), and a programmatic readiness aspect (e.g., a Confirmation Readiness Review - CRR). The latter considers the results of the technical design assessment (e.g., the PDR) while also addressing cost, schedule, risk and risk management. The two components need not be done as separate reviews. A review board is established by the project, consisting of members appropriate to the subjects to be reviewed, but not having any direct association with the project.

For Discovery projects and the medium class of Explorer projects (MIDEX), OSS will normally ask the Langley Research Center (LaRC) Space Science Support Office (SSSO) to conduct an independent Confirmation Assessment (CA) as a prerequisite to the Confirmation Review (CR). A LaRC staff member coordinating this assessment works with the Project Manager to enable the conduct of this assessment with minimal impact to the project flow. For Roadmap-initiated projects, the process for confirmation is identical to that for AO-initiated projects, except that the CA may be performed by an organization other than the LaRC SSSO.

If an independent Confirmation Assessment is required, the PE works with LaRC, or other organization, to form an independent team to perform the assessment. This is conducted typically by the team's attendance at the review(s) established by the project as described above, and interaction with project staff. The CA team is chartered by and reports to the SSE AA through the PE.

After completion of these reviews, the chair of the Confirmation Assessment presents their preliminary findings to the Project Manager, the Program Manager, the Program Executive, and representatives of the project review board from the implementing Center/organization. As these findings are modified and finalized, the CA team chair continually communicates them to the Project Manager, Program Manager and the Program Executive.

The PE provides this project's Program-Level Requirements Appendix to the Program Plan, containing the proposed NASA Headquarters-controlled requirements, for the Space Science Deputy Associate Administrator's endorsement. (Note: All required parties except the SSE AA should have already concurred on this document.) Also, pre-Confirmation briefings to the DAA by the project and the Confirmation Assessment chair are held, if requested.

Results of the review activities are reported to the PMC at the implementing NASA Center or organization in a Confirmation Readiness Review (CRR). The PMC chairman decides if the project is ready to seek confirmation and whether to recommend to the SSE AA that the project proceed to Implementation. If the governing PMC does not recommend transition to Implementation, the project recycles through the Formulation subprocess, addressing whatever deficiencies were identified as the rationale for not proceeding to Implementation.

If the Center governing PMC recommends that the project proceed to Implementation, the Confirmation Review is held with the AA. The PE coordinates the establishment and conduct of the Confirmation Review upon project notification of a successful CRR at the Center. At the Confirmation Review (of 2 hours duration or less), a summary presentation is made by the Project Manager and/or Principal Investigator, presenting a brief summary of the project objectives, the results of the CRR and the recommendations of their Center PMC. The chairperson of the CA team presents its findings and recommendations. The SSE AA and the Science Board of

Directors hears all the recommendations, and assesses the prospect of the mission being able to meet the science objectives on schedule and within budget. At the conclusion of the Confirmation Review, the SSE AA decides whether to authorize project transition to Implementation.

With a "Confirm" decision by the SSE AA, and if there are no outstanding items in the Program-Level Requirements Appendix, the project is confirmed for Implementation and the document can be signed by the SSE AA at the conclusion of the CR. Authorization to proceed is subsequently issued in a confirmation letter drafted by the PE for SSE AA signature. The Resources Management Division is notified to release the corresponding funding to the project per the approved budget plan. If there are outstanding items in the Program-Level Requirements Appendix, such items should be resolved and then presented to the SSE AA in a subsequent meeting when the document is complete and ready for SSE AA signature. Confirmation may be withheld until this is accomplished, or may be conditionally granted. Implementation funding cannot be released to the project until such issues are resolved.

A "No Confirmation" decision by the SSE AA can direct the project back to the Center for further Formulation or it can terminate any further effort.

For all space science projects, the PE should work with the project to close out all actions and recommendations from the Confirmation Review as soon as possible. Some action closeouts may be required before the project receives approval to begin Implementation Phase C. The PE should also work with the Project and Program Office and with OSS Public Affairs to issue a press release for start of Implementation whenever the approval letter is sent to the PI and the Project.

7.5 IMPLEMENTATION SUBPROCESS (PHASES C, D & E)

The Implementation subprocess implements the approved program/project requirements and plans. It focuses on translating the input products that come from Formulation into the production of formal output products and services for the designated customers. During Implementation, the PE needs to ensure the following actions and infor-

mation, not necessarily all inclusive, are developed and documented:

1. Update Program & Project Plans as required.

2. Baseline the PCA with an annual review and update.

3. Finalize Science Data Management Plan(s).

4. Finalize agreements with other NASA and non-NASA U.S. organizations for required support.

5. Finalize Space Operations Service Level Agreement with the SOMO.

6. Finalize international agreements with foreign partners, either LOA's or MOU's as required.

7. Finalize NEPA compliance documentation.

8. Finalize Orbital Debris Assessment.

9. Generate Headquarters Mission Contingency Plans and Mission Success Criteria.

10. Perform the Nuclear Launch Safety Approval process (if sufficient nuclear material is present on the spacecraft).

11. Receive Launch Readiness Statement from Center.

12. Generate any other program and project-unique documentation specifying NASA Headquarters requirements or constraints.

7.5.1 Phase C/D Support to Center Implementation

NPG 7120.5 designates the Lead Center Director as having responsibility for Implementation of missions. This doesn't mean that the SSE AA gives up all interest in projects once they reach the Implementation stage. Certainly, the movement of program management to the NASA Centers has removed the day-to-day oversight from the purview of NASA Headquarters. However, missions are selected to fulfill specific portions of the SSE Strategic Plan, and the SSE AA has a vested interest in ensuring the Centers carry out their assigned missions. The SSE AA assigns primary responsibility to the Program Executive for tracking the performance of a project against the program-level requirements and against the schedule and cost cap.

The PE must continue the program/project assessment and reporting tasks as described in Subsection 7.3.5. These continue throughout the life of the project. Also during Implementation, the PE becomes a primary advocate for the launch vehicle manifesting process with Code M, whether the project is to launch on an Expendable Launch Vehicle or the Space Shuttle. Support of Flight Planning Board and Flight Assignments Working Group meetings are essential to maintaining proper communication. The next subsection describes what the PE must do to ensure approval for launch.

Another key task is to monitor the progress of implementation of international agreements through the system, from collection of negotiated requirements from the projects to the drafting of the agreement in Code IS, to the progress through the various departments and agencies that must provide approvals. One key forum for tracking agreement progress is the Space Science Pending International Agreements Database, and the associated monthly meetings held with Code I.

7.5.2 Launch Preparation and Support

Required Launch Documentation

The following basic set of documents is required prior to the launch of any given mission: (a) compliance with the National Environmental Policy Act (NEPA) necessitates either an Environmental Assessment (EA) or Environmental Impact Statement (EIS); (b) Nuclear Launch Safety Approval (if sufficient nuclear material is present on the spacecraft); (c) Mission Success Criteria; (d) appropriate Contingency Plans; and (e) a statement from the Lead Center Director certifying readiness for launch. The flow of activities involved in the development of these documents is given in Office Work Instruction HOWI8630-S008. This OWI is the authoritative instruction for performance of this task. To ensure use of the most current OWI, always check http://www.hq.nasa.gov/hqiso9000/library.htm.

Figure 7.5-1 (from HOWI8630-S008) provides an overview of the required documentation. The PE bases the order of document preparation on the legal requirements and project complexity. In general, NEPA compliance commences in Formulation, with a target for completion prior to

the Critical Design Review in Implementation. If sufficient nuclear material is anticipated (as determined early in the NEPA process), the Nuclear Launch Safety Approval process also commences.

The Mission Success Criteria and Contingency Plans are usually prepared approximately three months prior to launch. The Launch Readiness Statement is usually received within one month prior to launch. The PE also determines if there are mission-unique requirements that necessitate the preparation of additional pre-launch NASA Headquarters documents.

The PE executes the NEPA Compliance Process, as specified by HOWI8630-S008. The PE should work closely with the designated NEPA compliance individual within the Flight Programs Division. The PE is responsible for the preparation of the Environmental Impact Statement in accordance with applicable regulations and law. A Notice of Intent is published in the Federal Register prior to preparing the Draft EIS, and when the Draft EIS is complete, a Notice of Availability is published in the Federal Register. Another Notice is published whenever the final EIS is available. The PE prepares the Record of Decision that is approved by the SSE AA.

The PE executes the Launch Approval Process, as specified by HOWI8630-S008. The Project at the Lead Center prepares the Safety Analysis Report (SAR) and delivers it to the Program Executive, nominally 12 months prior to launch. The Interagency Nuclear Safety Review Panel (INSRP) receives and reviews the SAR and prepares a Safety Evaluation Report that is delivered to the PE prior to launch. The PE uses this information to prepare and coordinate the Nuclear Launch Safety Approval Request. The Request is signed by the NASA Administrator for submittal to the Office of the President. The Office of the President renders a Nuclear Launch Safety Approval decision and notifies NASA in writing of the results. A positive Nuclear Launch Safety Approval decision is mandatory for launch.

Approximately 3 months prior to launch, the PE prepares the Mission Success Criteria based on the mission's program-level requirements and the
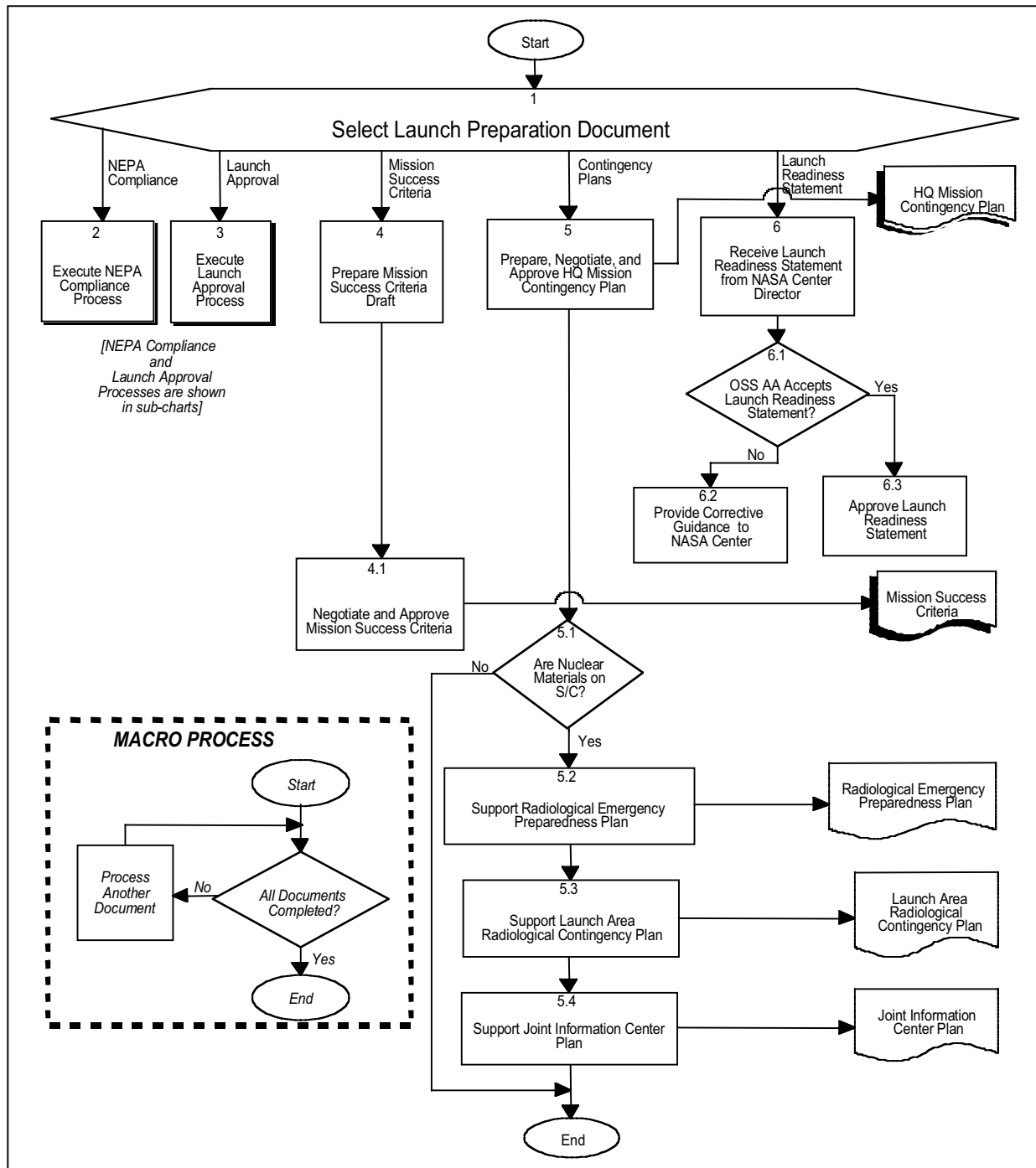
Figure 7.5-1 Launch Preparation Documentation Process

as-built spacecraft configuration. The PE coordinates review with the Program Scientist, the Science Director, the Program and Project Managers, the Project Scientist, and others as appropriate. The SSE AA provides final approval. The PE maintains the Mission Success Criteria until end of mission.

The PE prepares the NASA Headquarters Mission Contingency Plan in accordance with NPD 8621.1, negotiates concurrences with the appropriate Associate Administrators, and obtains approval from the SSE AA.

The SSE AA and the PE receive the Launch Readiness Statement from the Lead Center Director, usually within one month of launch. If the Launch Readiness Statement is acceptable, the SSE AA (or designee) provides approval during readiness reviews at the launch site.

7.5.3 Transition to Science Operations (Phase D to E)

Transition of management responsibility for a flight program from the Flight Programs Division (Code SD) to the Research Program Management Division (Code SR) occurs after launch when the spacecraft is in its final stable science data-collecting orbit, on-orbit check-out has been completed, and the mission is ready to begin the science acquisition phase. Due to their technology focus, New Millennium projects and other technology flight validation projects do not transition to Code SR, unless there is a science-focused extended mission.

Earth orbital missions typically have a 30-to-90 day on-orbit checkout period. Once the on-orbit checkout is completed and the spacecraft is ready to begin science data acquisition, Program Executive responsibility will be transferred to Code SR. In special situations, such as the Hubble Space Telescope (HST) program, where development of hardware continues because of the Space Shuttle servicing capability, management responsibility for program implementation and mission operations, as well as HST servicing mission development, has been assigned to Code SD. Therefore, HST operations remain an SD responsibility until such time as servicing is no longer performed.

Planetary missions typically have an extended cruise phase, in some cases several years, before the spacecraft is inserted into planetary orbit and checked out, and data acquisition begins. For these missions, Code SD will maintain Program Executive responsibility through any planetary gravity assist phases, and through completion of any encounter mission operations system development and encounter sequence development. Management responsibility will transfer to Code SR at a mutually agreeable point, such as after the final planetary assist flyby or following the Encounter Readiness Review for the primary target.

Each such mission may have unique aspects and therefore the two Division Directors, along with the Program Executives, will make a determination of the specific transfer point. The intent is to transfer a project whenever the predominant activity switches from engineering to science data collection.

For planetary orbiter missions, such as Mars Global Surveyor, management responsibility transfers to Code SR following orbital insertion (including aerobraking), completion of the in-orbit checkout, and confirmation of readiness to begin primary science data acquisition. Transition of management responsibility for planetary lander missions occurs after landing and on-surface checkout, typically a few days following touchdown.

After handoff of a mission to Code SR, the Code SD PE then assumes the role of Program Engineer for the mission and supports the SR PE, as requested, to address engineering issues requiring historical knowledge of the project. The Code SD PE should be forwarded all press releases and incident reports and kept informed of anomalies. The Program Engineer should be invited to participate in or observe any HQ-level failure board.

Note that keeping the Code SD PE in the loop is the mutual responsibility of the two PE's, and the degree to which this is done, which may evolve over time, should be agreed between these two people.

Here is a checklist of Code SD PE responsibilities to effect the transition:

1. Determine the appropriate point of transition for a given mission, to be done by the relevant Code SD PE and the Code SR PE to "inherit" the mission. If the transition event is not obvious, or there are unique aspects to the mission, involve the SD and SR Division Directors in this determination.

2. Well in advance of the SD/SR handoff, begin including the Code SR PE in activities for informational purposes, i.e., inviting the PE to reviews, copying the PE on progress and incident reports, introducing the PE to appropriate project personnel, etc.

3. Draft a "transition" memo to document when the transition is to occur, to be signed by both the SD and SR Division Directors.

4. Ensure that the Code SR PE has received copies of the relevant documents (PCA, Program Plan, Program-Level Requirements Appendix, Mission Success Criteria, Headquarters Contingency Plan, MOU's, MOA's, LOA's, etc.). The official ISO 9000 records of these documents, where appropriate, are to remain in the Code SD files as the OSS repository.

5. Ensure that the handoff of budget responsibility has been discussed between the Code SD and SR PE's, and the Code SP Program Analyst.

6. Transfer or copy any relevant personal project files, paper or electronic, from the Code SD PE to the Code SR PE, if deemed appropriate, and any "historical" material that relate to international, inter- and/or intra-agency agreements, particularly relating to expiration and/or termination criteria or dates.

7.6 EVALUATION SUBPROCESS

The Evaluation subprocess as discussed by NPG 7120.5 deals with program evaluation only by external teams (e.g. IA, IAR, EIRR, etc). The purpose of Evaluation is to independently assess the continuing ability of the program to meet its technical and programmatic commitments and to provide value-added assistance to the Program Manager as required. This subprocess is in addition to internal reviews and evaluations, such as the Project's Standing Review board. However, where practical, reviews can be combined to reduce their total number and cost. The Evaluation subprocess consists of the planning and conducting of reviews and assessments during Formulation and Implementation of a program.

Evaluation of space science programs and projects is accomplished through various status reviews and independent or external independent readiness reviews. These specific reviews are described below. Typically, the single-project programs are required to report to the NASA HQ PMC and to be subject to NAR and IAR reviews. The SSE AA may also request an EIRR be estab-

lished. In general, the projects of a mission series report to the Lead Center PMC and transition between phases with Confirmation Reviews, and therefore are not subject to Headquarters-initiated independent evaluation reviews, except for Confirmation Assessment as discussed in Subsection 7.4.2. Multi-project programs may, however, be subject to an IAR at the program level. Also, the NASA HQ PMC may choose to elevate any specific project to their authority as governing, thus making them subject to these external reviews.

The Lead Center Program Management Council includes a representative of the SSE AA, a representative from each of the involved supporting Centers, the functional office directors at the Center, a representative from the SOMO (if appropriate), and others as named by the Lead Center Director. The governing PMC reviews the status of all programs and projects on a regular basis (normally quarterly or monthly) including those that report to the NASA HQ PMC as governing.

7.6.1 Program Executive Responsibilities for Evaluation

The PE is responsible for initiating the appropriate independent performance assessment per guidance of Subsection 2.4 of NPG 7120.5. For an IA, NAR or IAR, the PE works with the LaRC IPAO to help select team members that have the correct expertise for the specific project to be reviewed. The PE also works with IPAO to establish the charter for the review and supports conduct of the review.

Since an EIRR is the independent review activity under the authority of the SSE AA, the PE assembles a list of prospective candidate EIRR chairpersons and presents it to the SSE AA for a selection. Then the PE works with the selected chairperson and the project to complete the team membership according to the needs of project content, and establishes an approved charter for the review team's assessment activity.

For all independent reviews, the PE monitors the assessment performed by the review team and the presentation of its findings to the governing Program Management Council and/or the SSE AA. The PE also supports the project in imple-

menting any approved findings from the independent assessment

7.6.2 Independent Evaluation Reviews

This review set consists of the IA, NAR, IAR, EIRR and Red Team reviews, each addressed below. Currently, these reviews can have different review boards, although there is significant effort to utilize IA members to conduct the NAR and to use as many NAR members for each IAR as possible. A change is being considered to define a single team to perform the functions of all four of these current external reviews. Proposed by the Chief Engineer's Office, this team is to be called the Independent Review Team (IRT) and would report simultaneously to both the Chief Engineer and the SSE AA. Currently, the concept is being tested in Code S on the Mars '03 Rover project and on a couple of projects in Code Y.

IA (Code AE, LaRC IPAO)

At the request of the governing PMC, the SSE or the Associate Deputy Administrator, the Chief Engineer (Code AE) directs an Independent Assessment (IA) of a program. IAs are conducted by the IPAO at LaRC and are technical and life cycle cost (LCC) assessments of a project in the early stages of Formulation.

An IA:

- Is performed in support of the NASA HQ PMC oversight of programs/projects that are early in the Formulation subprocess.

- Is conducted by a team composed of knowledgeable specialists from organizations outside of the advocacy chain of the program/project.

- Provides the NASA HQ PMC with an in-depth, independent validation of the advanced concepts, program or project requirements, design concept integrity, system/subsystem trades, life cycle cost, realism of schedule, risks and risk mitigation approaches, and technology issues.

- Provides suggestions of alternative system and/or subsystem design approaches which offer potential for reduced costs and risks or improved system performance.

NAR (Code AE, LaRC IPAO)

All programs subject to NASA PMC evaluation are subject to a Non-Advocate Review (NAR) in order to obtain approval to enter Implementation. The role of the NAR in the Approval process was documented in Subsection 7.4.1. The NAR board evaluates the program/project against the proposed Program Commitment Agreement to assess whether or not the commitments can be achieved. An IA team can satisfy the requirements for a NAR review board, if the team can be re-assembled at the proper time for the review. The findings of the NAR board will be presented to the NASA HQ PMC in order to obtain approval for the project to begin Implementation.

IAR (Codes AE, B, LaRC IPAO)

All programs and projects subject to NASA HQ PMC evaluation are reviewed each year after entering Implementation by an Independent Annual Review (IAR). The conduct of each year's review is coordinated between the IPAO and the Program Manager to minimize program disruption. Where practicable, reviews are combined with standard project reviews in order to reduce the impact to the project.

An IAR is intended to provide a validation of conformance to the Program Commitment Agreement. An IAR is to perform the following tasks:

- Assess progress and milestone achievement against original baseline.

- Review and evaluate the cost, schedule, and technical content of the program over its entire lifecycle.

- Assess technical progress, risks remaining, and mitigation plans.

- Determine if any program deficiencies exist that result in revised projections exceeding predetermined thresholds.

The IAR team will consist of as many of the NAR team members as it is possible to bring together. Their findings will be presented first to the project and/or program at the Center, then to the SSE at Headquarters, then to the Chief Engi-

neer's Office and last, if required, to the NASA HQ PMC.

EIRR's (SSE AA)

For programs with exceptional risk, higher cost, or high visibility, the SSE AA (or the PE for the SSE AA) may choose to establish an External Independent Readiness Review to validate the program's performance against the program-level requirements and objectives set forth in the Program Plan. The EIRR reports to the SSE AA, and only at the request of the SSE, reports the results to the governing PMC. EIRR's are performed in support of the SSE AA's oversight of approved programs and projects. The EIRRs are conducted by a team of highly knowledgeable specialists from organizations outside of the advocacy chain of the project. In addition, EIRR team members are generally from organizations outside of NASA. This approach allows access to a larger pool of resources with potentially more focused skills, raises confidence of senior NASA management, elevates and obtains attention to issues, and highlights lessons learned from other programs.

The PE is fully responsible for initiating an EIRR, including developing the charter, recommending prospective chairpersons to the SSE AA, obtaining commitment from prospective team members, working with the LaRC Space Science Support Office (or other organization) to establish contracts for team members, coordinating with the project for reviews, and ensuring publication of the review findings. In most cases, a review by an established EIRR team will substitute for an IA or a Confirmation Assessment.

Red Teams (Center Management)

After the Mars '98 failures, the NASA Administrator challenged the Center Directors to implement Red Team reviews for every project within one year of launch. The focus of these reviews is for an independent team to ask the project "what could go wrong" with this mission and then to examine their mitigation plans for these potential risks. A key element of a Red Team review is for the team to assess the project's risk management tools and the findings from their application, specifically for such tools as Failure Modes and Effects Analyses (FMEA), Fault Tree

Analyses and Probabilistic Risk Assessments (PRA).

The Center Directors have delegated Red Team reviews to the center Systems Management Offices, which are responsible for developing the charter, selecting and employing team members, organizing the reviews and publishing the results. The PE's only responsibilities are to maintain cognizance of the Red Team process for their project, to keep the SSE AA and DAA informed of activity and to ensure the results are published and actions addressed to closure

7.7 PROGRAM MANAGEMENT RE-SPONSIBILITIES

For each project, whether it be a single project in a program or one project in a mission series, four positions make up the Headquarters management team. Each science project is assigned to one of the four science themes, so the team consists of the Science Director, the Program Executive, the Program Scientist and the Program Resource Analyst. Each member of this team must be aware of major decisions to be made relative to the project and be a key voter on options to resolve issues. They must work together to present a united stance to the Lead Center and their Program and Project Managers.
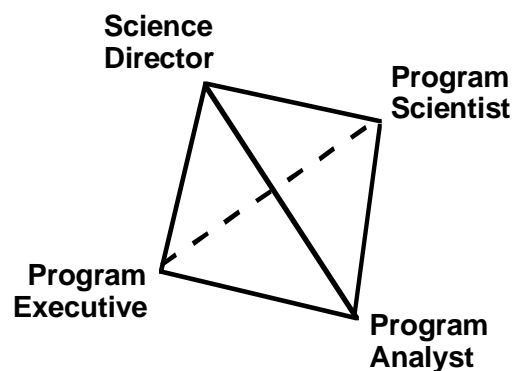

Figure 7.7-1 HQ Project Management Team for a Given Science Project

Figure 7.7-1 represents this relationship as a tetrahedron, where each of the four vertices are connected to the other three. The Program Analyst in Code SP works with the others to manage the project's budget. For technology development projects such as those in the New Millennium

Program, which do not have a science focus and are thus not assigned to a science theme, the fourth member of the team, in lieu of the Science Director, is the SSE Technology Director.

There are other positions, not represented above, that are also key individuals in project management. Theme Integrators have been appointed in the Flight Programs Division to coordinate the overall division support to the Science Director of a theme. However, their focus is on the overall theme, and not on any specific project within the theme. The Flight Programs Division Director provides overall coordination for flight program management. And last, but by no means least, are the Program and Project Managers at the Lead Center, who supply critical direct management of the overall program. Without these positions, projects would never get off the drawing board.

7.7.1 Role of the Program Executive

The SSE Associate Administrator is responsible for providing strategic stewardship for the Enterprise. It is the SSE AA's responsibility to manage Program Formulation. As permitted in the NASA Strategic Management Handbook, the SSE AA designates individuals at NASA Headquarters to sponsor specific programs in accomplishing their duties. In accordance with the responsibilities of an EAA as defined by NPG 7120.5, Appendix D, the SSE AA has delegated (through the Science Directors and Division Directors) the following responsibilities to the Program Executive during Formulation and Implementation of the program. These responsibilities are time-phased into four groups beginning with initializing programs, then documenting the Formulation subprocess, monitoring the Implementation subprocess, and overall, assessing the program and project performance.

Initializing Programs:

- Represent theme interests on working groups having a charter to define classes of future missions.

- Establish working groups to determine the advanced technologies necessary to enable future space science missions.

- Initiate studies to define new missions and determine their feasibility and desirability.

- Maintain working relationships with NASA Centers as required to have a sound foundation in recommending Center program responsibilities.

- Understand the scientific relevance of both current and future space science programs to the SSE Strategic Plan.

- Provide liaison with the launch vehicle provider organization in Code M.

- Develop and maintain key peer-to-peer working relationships with established NASA partners in order to facilitate the negotiation of new working agreements for cooperative programs.

- Work with the LaRC Space Science Support Office and Code SR as required during AO activities up through formal release. Typically this entails representing program management issues from the NASA Headquarters perspective, answering questions from proposing organizations, especially in the area of NASA Headquarters policy, representing NASA Headquarters programmatics at pre-proposal conferences, and helping resolve policy issues.

- Work with the Program Scientist, the Program Analyst, and the relevant Science Director to establish the budgetary cost cap.

- Identify need for environmental impact or assessment and define level of activity.

- Perform as liaison between project and Code I to initiate and achieve international agreements

Documenting Formulation:

- Write the Formulation Authorization Document and negotiate approval.

- Formally establish program objectives, requirements, and metrics. Prepare Level 1 requirements and negotiate approval.

- Write the Program Commitment Agreement and negotiate approval.

- Write letter of assignment to selected Lead Center for Program Delegation.

- Write Project Authorization Letters for newly selected projects.

- Recommend the level of governing Program Management Council for each program or project.

- Recommend and review establishment of program/project budget.

Monitoring Implementation:

- Monitor and review NASA Center establishment of program/project staffing.

- Monitor and review Center establishment of program/project budget.

- Monitor and review program/project development of baseline schedule.

- Monitor and review program/project management of risk.

- Review implementation of key agreements and contracts for launch services, spacecraft acquisition, science instruments, and other mission critical items specific to the program.

- After the transition to operations, serving as Program Engineer, support the Code SR PE, when appropriate, to address issues requiring NASA Headquarters actions for resolution.

Assessing Performance:

- On a regular basis, assess program performance against requirements, providing NASA Headquarters insight as required.

- Establish working relationships with senior management in provider organizations.

- Attend and report on Center-level status program reviews (e.g. governing PMC).

- Attend and report on selected project reviews, including Mission Definition Review (MDR), Systems Requirements Review (SRR), Preliminary Design Review (PDR), Critical Design Review (CDR), and Flight Readiness Review (FRR).

- Provide advocacy and program support in NASA Headquarters.

- Address issues requiring NASA Headquarters actions for resolution, and facilitate NASA Headquarters actions as required.

- Review findings from major reviews. Consult with Center Program Management to develop actions and decision requirements for NASA Headquarters. Facilitate and monitor NASA Headquarters response.

Theme Integration

A Program Executive in each science theme is appointed by the Flight Programs Division Director to perform the function of Theme Integration. Theme Integrators provide focal points for Flight Programs Division support to the Science Directors for each theme. The primary responsibilities in support of a Science Director are as follows:

- Support definition of future mission options, including integrating the programmatic, technological and budgetary planning.

- Support development of science and technology theme requirements and roadmaps.

- Integrate theme project status and review documentation, including budget status and projections, for Science Director presentations.

- Ensure effective coordination of theme communications with supporting Program Executives.

Also, the Theme Integrator has responsibilities in support of the Flight Programs Division Director, which include:

- Provide backup to responsible Program Executives as needed.

- Provide management support to PE's for institutional issues at theme Centers and with other Headquarters offices.

- Support Division Director in preparation of theme project status information, including budget.

7.7.2 Role of the Program Scientist

The Program Scientist is an integral part of the program management team and will be involved in program and project development.

While many other tasks are performed by the Program Scientist (see Subsection 6.3.5), those that specifically relate to program management are as follows:

- Develop science rationale, goals, and objectives for each program and project.

- Work with the Program Executive to establish Level 1 requirements.

- Working with the PE, administer the program's Level 1 scientific requirements and science policies.

- Manage the process of soliciting instruments and science investigations for NASA-initiated missions.

- Establish policy for forming the science experiment teams and manage the process for soliciting team members.

- Establish policy for data rights, public access to data, and establishment of a science data center.

- Establish policy for participating or interdisciplinary scientists, guest observer programs, and data analysis programs, and manage the process for soliciting participants.

- Work with the PE to establish funding levels for Phase E mission operations and data analysis.

- Work with the PE to establish annual budget priorities.

- Work with the PE to establish descope options when technical, cost, or performance trade-off's necessitate changes in the scientific content of the program.

- Provide science perspective and guidance at regular program status reviews.

- Provide program science advocacy within NASA and to the science community.

7.7.3 Role of the Program Manager

The Program Manager is the senior person at the Lead Center who interfaces with the PE in matters of program direction affecting cost, schedule and technical scope of work, and who implements the policy and guidelines received from the PE. The Program Manager may have one or more Project Managers reporting to him/her, depending on the structure of the specific program. A single-project program may have separate individuals performing these roles, or both may be invested in a combined Program/Project Manager. The Program Executive is dependent on the Program and Project Managers at the Lead Center to carry out the following responsibilities:

Initializing Programs:

- Support NASA HQ in conducting mission studies to develop mission concepts and determine feasibility.

- Support NASA HQ in program planning, including recommending program objectives, Level 1 requirements, mission success criteria, implementation guidelines, and top-level budget and milestones.

- Support NASA HQ in the preparation of any domestic and/or foreign agreements (MOU's, MOA's and LOA's) needed for collaboration. Develop working-level domestic/international agreements after these top-level agreements are negotiated.

- Negotiate inter-Center support agreements.

- Support NASA HQ in new start approval activities.

- Prepare Program Plans and Project Plans.

- Support NASA HQ in the development of PCA's.

- Develop launch vehicle requirements and launch windows and work with the PE to obtain manifested dates.

- Develop project performance metrics that are accepted by the NASA HQ PE.

- Develop Risk Management Plans and work with the PE to determine risk mitigation strategies. Determine single point failure criteria.

- Conduct trade studies to develop a viable project architecture that will be approved by OSS. This involves conducting technical/cost/schedule tradeoffs.

- Ensure a technology plan is developed and executed in a timely fashion so all technology

developments are completed before approval to enter Implementation is requested.

- Develop and obtain appropriate approvals for the project-level documentation required to get ready for implementation (e.g. project plan, Work Breakdown Structure (WBS), detailed budgets and schedules, make/buy decisions, statements of work, and requests for proposals).

Implementing Programs:

- Meet program milestones on time, within cost, while meeting the Level 1 requirements

- Allocate budget to elements of the programs.

- Manage project contingency funds.

- Oversee the execution of the Program Plan.

- Control program/project changes.

- Approve Project Plans and associated changes to these documents.

- Integrate the planning and execution of individual projects or programs comprised of multiple, inter-dependent projects.

- Ensure compliance with applicable Federal law, regulation, executive order, and Agency directives.

Assessing Performance:

- Review and report program/project performance to Center management and the PE in a timely way, meeting the guidance given by the PE.

- Provide POP budget responses.

7.8 PROGRAM/PROJECT TAILORING

Provide Aerospace Products and Capabilities (PAPAC) processes and requirements in NPG 7120.5 provide managers the framework to tailor approaches for formulating and implementing NASA's increasingly diverse programs and projects. In particular, managers of mission series such as Discovery, Solar Terrestrial Probes, New Millennium, can tailor approaches consistent with program or project characteristics such as size, complexity, cost, flight frequency and risk. Approved PCA's, Program Plans and Project Plans document the tailoring decisions.

For example, the Discovery and Explorer Programs have adopted streamlined program management structures, with NASA oversight and reporting requirements limited to those which are essential to ensure agreed-upon science return in compliance with committed cost, schedule, and performance requirements. Investigator teams are allowed to use their own processes, procedures, and methods to the fullest extent practical, and are encouraged to develop and implement new ways of doing business when cost, schedule, and technical improvements can be achieved and mission risk is not compromised. The intention is to contain total life cycle cost for highly cost-constrained missions, and improve performance through the use of new technology, strict cost control, requirements control, and more efficient management by assigning increased responsibility to the Principal Investigators.

Each project of the Discovery and Explorer Programs, chosen from competitive Phase A downselect, is subject to a Confirmation Review with the SSE AA for approval to enter Implementation (Phase C). This Confirmation Review is a tailored process that takes the place of the Non-Advocate Review (NAR) referenced in NPG 7120.5. Confirmation Review Data Packages, tailored to meet NPG 7120.5 requirements, may in some cases take the place of the mission's Project Plan, if specified in the Program Plan.

Tailoring may take the form of modifications to special requirements documented in Subsection 4.0 of NPG 7120.5, such as Earned Value Management (EVM). While EVM is the NASA standard, some projects may be able to justify not using this paper-intensive system if other controls are in effect. Tailoring that increases risk to project success will be looked upon with disfavor unless the project can demonstrate alternate risk mitigation strategies.

Program tailoring must be documented in the Program Plan. This includes any specific tailoring that applies to all projects in a mission series. Project-specific tailoring will be documented in the relevant mission-specific Program Requirements Appendix to the Program Plans or in individual Project Plans.

7.9 BUDGET CONTROL & DESCOPING

One of the roles of a Program Executive is budget control, working in close coordination with the Science Director, the Program Scientist and the Program Analyst. This includes:

- Formulating the baseline budget cost cap which is incorporated into the PCA and Program Plan/Project Appendix, and

- Assessing the execution of the program, which includes tracking costs, risks and their mitigation strategies.

Provided that the requirements are preserved and due consideration has been given to the use of budgeted contingency and planned schedule contingency, the project will pursue scope reduction and risk management as a means to control cost. The Project Plan should define potential scope reductions and the time frame in which they could be implemented. The NASA Center(s) and OSS must agree to any scope reductions affecting the program-level requirements.

During Implementation, the project will develop the mission within the established performance, schedule and cost requirements identified in the documents. If at any time during development the PE believes the project is unable to achieve the requirements or that the project cost cap might be exceeded by more than an amount specified in its PCA and Program Plan, he/she can recommend to the SSE AA that a cancellation review be con-

ducted. A cancellation review is not required if the SSE AA agrees to change the requirements or if the project is able to descope the mission concept/design in order to stay within the technical, cost, and schedule constraints.

If neither of these occurs, then it is appropriate to recommend a cancellation review. At the review, the project presents to the OSS (1) rationale for relief from the requirements, and/or (2) actions taken to regain meeting the technical, cost, and schedule requirements. At the end of the review, the SSE AA decides whether the project may continue development and to allow changes to the requirements, if appropriate, or to cancel the project and to communicate the decision in writing to the governing PMC and Lead Center. If the governing PMC is the NASA HQ PMC, the SSE AA submits a recommendation for cancellation to the NASA HQ PMC, which makes the final decision. If changes to the requirements are agreed to, they will be documented in a revised PCA and Program Plan/Project Appendix.

The Chief Financial Officer (Code B) may also call a cancellation review if Code B believes the project will exceed its baselined development cost cap by more than 15%. In general, Code B will only be reviewing those projects/programs that report to the NASA HQ PMC. If Code B recommends cancellation at the conclusion of its review, the final decision will be made by the NASA HQ PMC.